PTO 2006-6337

Japanese Koouhou Patent Publication No. H03-13567, published January 22, 1991;

Application No. H01-146599, filed June 12, 1989; Inventors: Shigeru TSUKAMOTO
Assignee: Hitachi Maxell. Ltd

ELECTRON GUN TYPE VAPOR DEPOSITION DEVICE

1.Name of Invention

Electron Gun Type Vapor Deposition Device

Patent Claims

(1) An electron gun type vapor deposition device characterized in that it is designed such that multiple electronic beam generators are provided symmetrically for one deflecting coil cylinder, and the electron beams can be guided to the above-mentioned deflecting coil cylinder by a beam refracting coil provided in the center.

(2) An electron gun type vapor deposition device characterized in that in the description of claim (2) the above-mentioned multiple electron beam generators are provided so that the upper positive electrodes bifurcate, and since, at the same time, both the evaporation chamber and the electron gun chamber play the part of vacuum compartments, maintenance, replacement, adjustment, and inspection of the electron beam generators can be performed on individual pieces.

3. Detailed Explanation of Invention

(Field of Application in Industry)

The invention pertains to a vapor deposition apparatus.

(Prior Art)

Figs. 2 and 3 show the vapor deposition apparatus of Prior Art. Fig. 2 is an overall diagram of the vapor deposition device. Fig. 3 is a cross-section of an electron gun.

In Fig. 2, 1 is a vacuum chamber, 2 is a cover that can be opened and closed, 3 is the main vacuum pump, 4 is the film payout shaft, 5 is the payout roller, 6 is the input side centering roller, 7 is the input side guide roller, 9 is the coating roller, 10 is the output side centering roller, 11 is the takeup roller, 12 is the film takeup shaft; 13 is the crucible, 14 is the electron gun, 15 is the EB exhaust cylinder, 16 is the vacuum pump for EB, 17 is the deflecting coil cylinder; 18 is the coil cylinder support plate, 19 is the EB film, 20 is the electron gun cover, 21 is the O ring, 22 is the shutter shaft, 23 is the rotary activator, 24 is the elevator cylinder, 25 is the EB cylinder, 26 is the shutter bearing, 30 is the top positive electrode, 31 is the bottom negative electrode, 32 is the beam focus coil, 33 is the beam's X axis deflecting coil, 34 is the beam's Y axis deflecting coil, 35 is the fastening bolt; 36 is the electron beam generator, 37 is the electron gun chamber, A is the

is the payout roll film, B is the film, C is the takeup roll film, E is the electron beam, M is the vapor-deposited metal, and V is the metal vapor.

As shown in these Figures, in order to deposit and form a metal film on the film B, the vapor-depositing metal N inside the crucible 13 is ejected from one electron gun 14. The electron beam E is curved by the deflecting coil tube 17 to wards the center of the crucible 13. The vaporization metal M is heated and melted under vacuum, and the metal vapor V is vapor-deposited onto film B.

(Problems to be Solved by the Invention)

However, since in Prior Art, there was only one electron gun 14, in the event of trouble or wear of the cathode component inside the electron beam generator 36 of Fig. 3, the electron beam 3 was no longer generated, and the vapor deposition had to be suspended.

Moreover, even if the electron beam generator 36 must be replaced, it is hot at more than 100°C due to the heat generated by the high voltage current at about 30 thousand V that passes through it; moreover, since heat accumulates in the insulator, it is impossible to touch it by hand to carry out the replacement, so that it takes over 40 minutes for it to cool down. During the cooling period, the molten metal cools down from 1600~1800°C to 100°C.

Next, during the replacement with a spare electron beam generator, the generator through which the EB exhaust gas passes that contacts frame 19 and which is maintained in high vacuum by means of the EB vacuum pump 16, the rotary actuator 23 that rotates the shutter shaft 22 which rotates the inside of the shutter bearing 26, and the EB shutter 25 are pushed against the top of the bottom anode 31, and once they are converted into a separate compartment by the shielding elevator cylinder 24, the EB vacuum pump 16 is shut down, and the inside of the electron gun 37 is opened to the atmosphere.

Upon removing the electron gun cover 20, the electron beam generator 36 is lifted manually or by hoist crane and replaced with the spare electron beam generator. These consecutive replacement operations take about 10 minutes.

Upon replacement, in order to ensure that the electron beam generator 36 has stable characteristics under high vacuum, prior to using the device, parts are degassed, complete degassing takes about 30 minutes.

When degassing is over, first, high voltage is applied and from the electron beam generator 36 the electron beam E is accelerated towards the top anode 30 and the bottom cathode 31; it is focused and deflected by the beam focusing coil 32, beam X-axis deflecting coil 33 and the beam Y-axis deflecting coil 34; the metal M that has cooled down is reheated in the crucible 13 from Fig. 2. This reheating takes 30 min on an average.

As explained above, the vapor deposition device of Prior Art had a drawback in that, when the vapor deposition operation is suspended because of the trouble with electron beam generator 36 etc., generally it takes anywhere from 1 hour 40 minutes to 2 hours for the device to resume operation.

The purpose of this invention is to a vapor deposition device that eliminates the drawback of Prior Art and has high productivity.

[Means of Solving the Problem]

In order to achieve the above-mentioned goal, as shown in Fig. 1, this invention, is characterized in that multiple electronic beam generators are provided symmetrically for one deflecting coil cylinder, and the electron beams can be guided to the above-mentioned deflecting coil cylinder by a beam refracting coil provided in the center.

(Effect)

Providing multiple, for example, two, electron beam generators symmetrically per one deflecting coil cylinder achieves an effect that is essentially equivalent to providing multiple primary and secondary electron guns, making it possible to repair, replace, adjust, and inspect individual electron beam generators separately.

(Embodiment)

Next, we will explain this invention in conjunction with Fig. 1.

Two electron beam generators 36a and 36b are provided symmetrically with regard to one deflecting coil cylinder 17 above it, and the electron beam E is generated by either of the electron beam generators 36a or 36b.

This electron beam E is emitted towards the top anode electrode 30a or 30b which are fastened with bolts to the top electrode frame 51a or 51b, accelerated in the central axial direction by the bottom electrode 31a or 31b supported by the bottom electrode frame 40a or 40b, and travels directly towards the deflecting coil cylinder 17.

Upon refraction towards the central axial direction of the deflecting coil cylinder 17 by means of the beam refracting coil 55 accommodated in the top part of the deflecting coil cylinder 17 and upon focusing by the beam focusing coil 32, [the beam] is freely aimed at the vapor deposition metal M in the crucible 13 of Fig. 2 by means of the beam X axis deflecting coil 33 and the beam Y axis deflecting coil 34.

The generation of the electron beam E takes place under conditions of high vacuum at less than $5x10^{-5}$ mbar within the EB frame 19a or 19b achieved by means of the EB vacuum pump 16a or 16b and or by the exhaust pipe 15 a or 15b connected to them. Immediately prior to the start of the vapor deposition operation the closing is effected by the fan-shaped EB shutters 25a and 25b fastened to the shutter shafts 22a and 22b that rotate upwards by means of the rotary actuators 23a and 23b as well as elevator cylinders 24a and 24b. The shutter shafts 22a and 22b are supported by the shutter bearings26a and 26b and smoothly make rotary and elevator-like movements.

The electron beam generators 36a and 36b are fastened to the top flange surface of the EB frames 19a and 19b, with an O-ring sandwiched between them; for safety, they are accommodated inside the electron gun covers 20a and 20b. The bottom electrode frames 40a and 40b are fastened with bolts to the vacuum chamber 1 via the electrode frame support plates 50a and 50b. Similarly, the deflecting coil cylinder 17 is also suspended from the cylinder supporting plate 18 and fastened to the vacuum chamber 1 with the mounting bolt 35.

Moreover, in the event of an electron gun of Prior Art of the single head type shown in Fig. 3 the stripping of the vapor deposition metal that got deposited on the inner circumference of the deflecting coil cylinder 17 was only possible from the bottom. But in the event of the embodiment shown in Fig. 1, scaling and cleaning can be done easily because a deflecting coil cleaning hole 14 is provided in the central part between the electron beam generators 36a and 36b.

Specific parameters of this embodiment can be listed as follows:

Electron gun output:	10A x 30,000 V	300 KW
Electron beam generator: 2 units		
Electron beam configuration angle: 60°		
EB vacuum pump: turbomolecular type (360 l/sec)		
Rough pump for the same purpose: rotary valve type		2 each (20 m^3/sec)
Beam refracting coil: separate excitation		1
Beam focusing coil: separate excitation		1
Beam X and Y axis deflecting coil: separate excitation		1 each

(Effect of invention)

Provided in the vacuum deposition device of this invention are 2 sets each of electron beam generators 36a and 36b, EB frames 19a and 19b, EB vacuum pumps 16a and 16b, EB shutters 25a and 25b, top anodes 30a and 30b, and bottom anodes 31a and 31b; they are located symmetrically on the right and left of the beam refracting coil 55 as the center. Therefore if the electron beam generator 36a on one side malfunctions, by turning the high-voltage switch, the other electron beam generator 36 b can take over the heating of the metal M for vapor deposition within a matter of 2-3 minutes, therefore breaks in the vapor deposition operation can be kept down to 10 minutes.

If the EB shutters 25a and 25b are provided in the electron beam generators 36a and 36b, as in this embodiment, then since, for example, the electron beam generator 36b on the other side is shielded by the shutter 25b even while it is in the standby mode as a backup, there is no contamination by the metal vapor V etc., and the stability of the electron beam E is thus ensured.

Since multiple electron beam generators 36a and 36b are provided and any one electron beam generator can be used in the vapor deposition operation, any type of witch can be used, such as high-voltage transformer, joint control type, beam-scanning control type, beam monitoring type, etc., therefore equipment cost and space are both smaller than in Prior Art.

4. Brief Explanation of Figures

Fig.1 is a cross-section of the electron gun pertaining to this invention. Fig. 2 is a general diagram of the electron gun type vapor deposition device. Fig. 3 is a cross-section of the electron gun of Prior Art.

17 – deflecting coil cylinder; 19a, 19b – EB frames; 25a, 25b – EB shutters, 30a, 30b – top anodes, 31a, 31b – bottom anodes; 36a, 36b – electron beam generators; M – vapor deposition metal, E – electron beam.